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(54) Polyethylene glycol based  
de-icing and anti-icing  
composition

(57) The accumulation of ice on the exposed surfaces of an aircraft, for example the rotor blades of helicopters, can seriously affect the performance of the aircraft. Ice may be shed from or inhibited from forming on such surfaces by coating them with a paste, which advantageously has good resistance to erosion by rain and ice particles and comprises mixtures of polyethylene glycol, a low molecular weight alcohol preferably together also with shellac or polyvinyl acetate, a water insoluble plasticiser, and a detergent.

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## SPECIFICATION

## De-icing and anti-icing paste compositions

- 5 The present invention relates to de-icing and anti-icing paste compositions.

The accumulation of ice on the surfaces of certain machines exposed to the atmosphere, particularly aircraft, can be serious. For example ice which forms on the rotor blades or airframe of a helicopter will cause a loss in performance of the helicopter owing to the added weight and drag produced by the ice.

- 10 Ice may be shed from, or inhibited from forming on, exposed surfaces of interest by coating them with a suitable paste. UK Patent Application No 26428/77 describes such a paste which is particularly suitable for use on helicopter rotor blade surfaces. The paste includes glycerol gelled using gelatin. Unfortunately this paste is eroded in use by atmospheric ice, snow and rain particles.

- 20 It is an object of the present invention to provide a paste suitable for shedding ice or inhibiting its formation on a surface of interest and having a greater resistance to rain and snow particles than the known paste mentioned above.

- 25 According to the present invention a composition suitable for shedding ice or inhibiting its formation on a surface of interest comprises a mixture, in the form of a paste, of a polyethylene glycol together with a low molecular weight alcohol such as glycerol, ethylene glycol, tetramethylene glycol, methyl alcohol, ethyl alcohol or with a mixture of 2 or more of such alcohols.

- 30 The polyethylene glycol may be one with a molecular weight in the inclusive range 800-4,000. Preferably the molecular weight is about 1,500.

Preferably, the polyethylene glycol constitutes between 45 and 80 per cent by weight of the paste composition.

- 40 By a 'low molecular weight alcohol' is meant an alcohol having a molecular weight less than 100, so that the molecular weight is similar or less than the molecular weight of glycerol, 92.

Optional additional constituents for the composi-

- 45 tion which inhibit the dissolution of the paste in water are polyvinyl acetate or shellac.

A small proportion of a liquid detergent such as Teepol (Trade Mark), eg 0.5% by weight, may also form part of the paste composition to improve wet-

- 50 tability. Preferably, the low molecular weight alcohol(s) constitutes between 9 and 30 per cent by weight of the paste composition.

- 55 Preferably, the polyvinyl acetate and/or shellac constitutes between 0 and 30 per cent by weight of the paste composition.

Preferably the paste composition comprises:

- i polyethylene glycol of molecular weight 1,500: between 55 and 80% by weight,  
60 ii glycerol: between 9 and 30 per cent by weight, and  
iii shellac: between 10 and 17 per cent by weight.

- Compositions incorporating shellac have a tendency to become brittle at low temperatures but this may be advantageously overcome by incorporating a suitable water insoluble plasticiser in the composition. The plasticiser also helps to reduce the rate at which atmospheric rain and ice particles erode the composition and thus helps to prolong the life of the composition.

- 70 Preferably the water insoluble plasticiser is dibutyl phthalate and when incorporated in a de-icing composition of the present invention the constituents of the composition are preferably combined in the following proportions:

- i polyethylene glycol 1500: 65-80% by weight,  
ii low molecular weight alcohol: 6-10% by weight,  
iii shellac: 10-13% by weight,  
80 iv dibutyl phthalate: 5-13% by weight.

Examples of paste compositions embodying the invention will now be given. These compositions are produced by melting the constituent compounds together in the appropriate weight proportions to produce a homogeneous mixture.

TABLE 1

Mixtures of polyethylene glycol, molecular weight 1,500 (PEG 1500), glycerol and shellac.

	Mixture 1 Percentages by weight	Mixture 2 Percentages by weight	Mixture 3 Percentages by weight
PEG 1500	56 $\frac{2}{3}$	60	63 $\frac{1}{3}$
Glycerol	26 $\frac{2}{3}$	26 $\frac{2}{3}$	26 $\frac{2}{3}$
Shellac	16 $\frac{2}{3}$	13 $\frac{1}{3}$	10

TABLE 2

Mixtures of polyethylene glycol, molecular weight 1,500 (PEG 1500), glycerol and shellac.

	Mixture 4 Percentages by weight	Mixture 5 Percentages by weight	Mixture 6 Percentages by weight	Mixture 7 Percentages by weight
PEG 1500	66 $\frac{2}{3}$	70	70	73 $\frac{1}{3}$
Glycerol	20	20	16 $\frac{2}{3}$	13 $\frac{1}{3}$
Shellac	13 $\frac{1}{3}$	10	13 $\frac{1}{3}$	13 $\frac{1}{3}$

TABLE 3

Mixtures of polyethylene glycol, molecular weight 1,000 (PEG 1000), glycerol and shellac.

	Mixture 8 Percentages by weight	Mixture 9 Percentages by weight	Mixture 10 Percentages by weight	Mixture 11 Percentages by weight
PEG 1000	53 $\frac{1}{3}$	60	71	70
Glycerol	26 $\frac{2}{3}$	26 $\frac{2}{3}$	14.5	20
Shellac	20	13 $\frac{1}{3}$	14.5	10

TABLE 4

Mixtures of polyethylene glycol, molecular weight 4,000 (PEG 4000), glycerol and shellac.

	Mixture 12 Percentages by weight	Mixture 13 Percentages by weight
PEG 4000	46 $\frac{2}{3}$	60
Glycerol	43 $\frac{1}{3}$	30
Shellac	10	10

TABLE 5

Mixtures of polyethylene glycol, molecular weight 4,000 (PEG 4000), polyvinyl acetate and ethylene glycol.

	Mixture 14 Percentages by weight	Mixture 15 Percentages by weight
PEG 4000	40	66 $\frac{2}{3}$
Ethylene Glycol	40	16 $\frac{2}{3}$
Polyvinyl Acetate	20	16 $\frac{2}{3}$

TABLE 6

Mixtures of polyethylene glycol, molecular weight 1,000 (PEG 1000), polyvinyl acetate and glycerol.

	Mixture 16 Percentages by weight	Mixture 17 Percentages by weight	Mixture 18 Percentages by weight
PEG 1000	60	56 $\frac{2}{3}$	50
Glycerol	20	20	30
Polyvinyl Acetate	20	23 $\frac{1}{3}$	20

TABLE 7

Mixtures of polyethylene glycol, molecular weight 1,000 (PEG 1000), glycerol and methyl alcohol.

	Mixture 19 Percentages by weight	Mixture 20 Percentages by weight
PEG 1000	70	80
Glycerol	10	10
Methyl Alcohol	20	10

Mixtures 1 to 20 in the above Tables have been produced and tested in a low temperature chamber for their ice-shedding capability. The number of times ice could be formed on a layer of paste and removed before there was significant ice adhesion or before the paste was dissolved was determined. It was found from these tests that each of Mixtures 1 to 20 was suitable as an ice-shedding composition.

In use the Mixtures are softened before application to an exposed surface of interest eg a helicopter rotor blade surface.

Another example of a paste composition embodying the invention is as follows:

#### Mixture 21

15 Polyethylene glycol, molecular weight 1,500: 75% by weight

Ethylene glycol: 25% by weight

This mixture is made and prepared for use in a similar way to Mixtures 1 to 20. The wettability of this Mixture may be improved by the addition of 2 drops of Teepol, Trade Mark, (typically 0.5% by weight) to every 4 gm of Mixture 21 to yield:

#### Mixture 22

25 (A) Polyethylene Glycol 75% by weight of (A) and (B)

(B) Ethylene Glycol 25% by weight of (A) and (B)

(C) Teepol 0.5% by weight of (A), (B) and (C)

Mixture 22 was found to shed ice in very thin slivers from the surface of a test specimen held in a wind tunnel at  $-10^{\circ}\text{C}$  and with an air speed of 70 kn and a liquid water concentration of 0.6 gm/m<sup>3</sup>. Ice was prevented from forming on some parts of the specimen surface by Mixture 22.

A further example of a paste composition embodying the invention is as follows:

#### Mixture 23

Polyethylene glycol 1500: 76.2% by weight

Glycerol: 9.5% by weight

Shellac: 14.3% by weight

40 This mixture is made and prepared for use in a similar way to Mixtures 1 to 22.

TABLE 8

Mixtures of polyethylene glycol, molecular weight 1,500 (PEG 1500) glycerol shellac and dibutyl phthalate.

	<i>Mixture 24 Percentages by weight</i>	<i>Mixture 25 Percentages by weight</i>	<i>Mixture 26 Percentages by weight</i>	<i>Mixture 27 Percentages by weight</i>
PEG 1500	72.7	72.3	66.7	74.9
Glycerol	9.1	9.0	8.3	9.4
Shellac	11.8	12.5	12.5	10.5
Dibutyl Phthalate	6.4	6.2	12.5	5.2

TABLE 9

A mixture of polyethylene glycol, molecular weight 1,500 (PEG 1500), ethylene glycol, shellac and dibutyl phthalate.

	<i>Mixture 28 Percentages by weight</i>
PEG 1500	72.7
Ethylene glycol	9.1
Shellac	11.8
Dibutyl Phthalate	6.4

Mixtures 23 to 28 were made and prepared for use in a similar way to Mixtures 1 to 22 and tested in a low temperature chamber for their ice-shedding capabilities and their resistance to erosion by ice particles in an air stream.

Mixtures 23 to 28 were found to be effective at inhibiting the formation of ice on a surface and had good resistance to erosion by atmospheric ice particles.

#### 10 CLAIMS

1. A composition suitable for shedding ice or inhibiting its formation on a surface of interest comprising a mixture, in the form of a paste, of a polyethylene glycol and a low molecular weight alcohol or a mixture of two or more such alcohols.
2. A composition as claimed in claim 1 and wherein the polyethylene glycol has a molecular weight in the inclusive range 800-4000.
3. A composition as claimed in claim 2 and wherein the polyethylene glycol has a molecular weight of about 1500.
4. A composition as claimed in claim 1 and wherein the molecular weight of the or each alcohol is less than 100.
5. A composition as claimed in claim 4 and wherein the or each low molecular weight alcohol is selected from glycerol tetramethylene glycol, methyl alcohol, ethyl alcohol and ethylene glycol.
6. A composition as claimed in any one preceding claim and wherein shellac is incorporated in the composition.
7. A composition as claimed in claims 1, 2, 3, 4 or 5 and wherein polyvinyl acetate is incorporated in the composition.
8. A composition as claimed in any one preceding claim and wherein about 0.5% by weight of a liquid detergent is incorporated in the composition.
9. A composition as claimed in claim 6 and wherein the composition comprises 55% to 80% by weight of polyethylene glycol 1500, 9% to 30% by

weight of glycerol and 10% to 17% by weight of shellac.

10. A composition as claimed in claims 6 or 8 and wherein a water insoluble plasticiser is incorporated in the composition.

11. A composition as claimed in claim 10 and wherein the water insoluble plasticiser is dibutyl phthalate.

12. A composition as claimed in claim 11 and wherein the composition comprises 65%-75% by weight of polyethylene glycol 1500, 6%-10% by weight of alcohol, 10%-13% by weight of shellac and 5%-13% by weight of dibutyl phthalate.

13. A composition as claimed in any one preceding claim and which is substantially the same as any one of Mixtures 1 to 28 given hereinbefore.

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